What is claimed is:

1. A method of determining a best focus position of an object relative to a reference position in an optical imaging system, comprising the steps of:

a) forming a dark-field image of the object at different focus positions, each said dark-field image having a corresponding image intensity distribution with an average intensity and a variance of intensity;

b) forming a set of contrast values by calculating a contrast value for each said dark-field image based on said variance and said average intensity; and

c) determining the best focus position by fitting a Lorentzian function to said set of contrast values plotted as a function of said different focus positions.

2. A method according to claim 1, wherein said step b) further includes the steps of:

d) digitizing each said dark-field image such that said image intensity distribution for each said dark-field image is a digitized image intensity distribution comprising discrete gray-scale intensity levels I_n corresponding to a discrete plurality of n pixels; and

e) arranging each said digitized image intensity distribution into a histogram, $H(I_n)$, of an amount of said pixels having a given said gray-scale intensity level, I_n.

3. A method according to claim 2, further including the steps of:

f) calculating said average intensity for each said discrete image intensity distribution via the equation

$$\langle I \rangle = \frac{\sum_{I_n} H(I_n) I_n}{\sum_{I_n} H(I_n)};$$

g) calculating said variance for each said discrete image intensity distribution via the equation

$$\sigma_I^2 = \frac{\sum_{I_n} H(I_n)(I_n - \langle I \rangle)^2}{\sum_{I_n} H(I_n)}; \text{ and}$$

h) calculating said contrast value, C, for each said discrete image intensity distribution via the equation

$$C = \frac{\sigma_I}{\langle I \rangle}.$$

4. A method according to claim 3, wherein in said step c) of determining the best focus position includes performing a curve fit to the equation

$$C = a_1 + \frac{a_2}{(z - a_3)^2 + a_4},$$

wherein a_1, a_2, a_3 and a_4 are Lorentzian curve-fitting parameters, z indicates a distance along a focus direction, and said parameter a_3 corresponds to the best focus position along said focus direction.

5. A method according to claim 1, wherein the object comprises a region of interest on a substantially reflective substrate.

6. A method according to claim 5, wherein said region of interest includes a pattern formed on said substrate.

7. A method according to claim 6, wherein said pattern is a predetermined structure capable of scattering light.

8. A method according to claim 6, wherein said pattern is surface roughness.

9. A method according to claim 1, wherein said reference position is a coordinate system of an apparatus that forms said plurality of dark-field images.

10. A method according to claim 1, wherein the optical imaging system has a depth of field, and an effective focusing range of up to 10 times said depth of field.

11. An apparatus to automatically determine the best focus position of an object relative to a reference position comprising:

an optical imaging system having an optical axis, an image plane, and an object plane;

an object stage, arranged at or near said object plane and along said optical axis, capable of supporting and moving said object in response to an object stage electrical signal;

a light source arranged to illuminate the object such that said optical imaging system forms a dark-field image of said object at said image plane;

a detector arranged at said image plane and capable of generating a detector electrical signal in response to said dark-field image formed thereon;

an object stage control unit operatively connected to said object stage, to effectuate relative motion between said object stage and said optical imaging system;

and

a computer in electrical communication with said detector and said object stage control unit, said computer capable of processing said detector electrical signal and calculating a dark-field contrast value therefrom, and generating said object stage electrical signal to drive said object stage so as to optimize said dark-field contrast value.

12. An apparatus according to claim 11, further including a frame-grabber in electrical communication with said detector and said computer, said frame-grabber capable of forming a digitized dark-field image intensity distribution having gray-scale intensity levels.

13. An apparatus according to claim 12, wherein said optical imaging system has an outer edge with said light source arranged adjacent said outer edge.

14. An apparatus according to claim 13, wherein said light source is annular.

15. An apparatus according to claim 11, wherein said optical imaging system includes an objective lens and a tube lens.

16. An apparatus according to claim 11, wherein said detector is a CCD array having a plurality of pixels.

17. An apparatus to automatically determine the best focus position of an object relative to a reference position comprising:

an optical imaging system having an optical axis, an image plane, and an object plane;

an optical imaging system stage, arranged along said optical axis, capable of

supporting and moving said optical imaging system in response to an optical imaging system stage electrical signal;

an optical imaging system stage control unit operatively connected to said optical imaging system stage to effectuate movement of said optical imaging system relative to the object in response to the optical imaging system stage control unit electrical signal;

a light source arranged to illuminate the object such that said optical imaging system forms a dark-field image of said object at said image plane;

a detector arranged at said image plane and capable of generating a detector electrical signal in response to said dark-field image formed thereon; and

a computer in electrical communication with said detector and said optical imaging system stage control unit, said computer capable of processing said detector electrical signal and calculating a dark-field contrast value therefrom, and generating said imaging system stage electrical signal to drive said imaging system stage so as to optimize said dark-field contrast value.

18. An apparatus according to claim 17, further including a frame-grabber in electrical communication with said detector and said computer, said frame-grabber capable of forming a digitized dark-field image intensity distribution having gray-scale intensity levels.

19. An apparatus according to claim 17, wherein said optical imaging system has an outer edge, and said light source is arranged adjacent said outer edge.

20. An apparatus according to claim 17, wherein said light source is annular.

21. An apparatus according to claim 17, wherein said optical imaging system includes an objective lens and a tube lens.

22. An apparatus according to claim 17, wherein said detector is a CCD array having a plurality of pixels.

23. In a computer system, a method of determining the best focus position of an object relative to a reference position, based on a plurality of dark-field images of the object, comprising the steps of:

a) storing, in a computer readable medium, data corresponding to the plurality of dark-field images, each said dark-field image being associated with a different focus position and having an associated image intensity distribution with an average and a variance;

b) forming, in said computer system, a set of contrast values by calculating a contrast for each said dark-field image, based on said variance and said average; and

c) determining, in said computer system, the best focus position by fitting a Lorentzian function to said set of contrast values plotted as a function of said different focus positions.

24. A method in a computer system accordiug to claim 23 wherein said step b) further includes the steps of:

d) digitizing each said dark-field image with said image intensity distribution for each said dark-field image having a digitized image intensity distribution comprising discrete gray-scale intensity levels, I_n corresponding to a discrete plurality of n pixels; and

e) arranging each said digitized image intensity distribution into a histogram, $H(I_n)$, of an amount of said pixels having a given said gray-scale intensity level, I_n.

25. A method in a computer system according to claim 24, further including the steps of:

f) calculating said average intensity for each said discrete image intensity distribution via the equation

$$\langle I \rangle = \frac{\sum_{I_n} H(I_n) I_n}{\sum_{I_n} H(I_n)};$$

g) calculating said variance for each said discrete image intensity distribution via the equation

$$\sigma_I^2 = \frac{\sum_{I_n} H(I_n)(I_n - \langle I \rangle)^2}{\sum_{I_n} H(I_n)}; \text{ and}$$

h) calculating said contrast value, C, for each said discrete image intensity distribution via the equation

$$C = \frac{\sigma_I}{\langle I \rangle}.$$

26. A method in a computer system according to claim 25, wherein said step c) of determining the best focus position includes performing a curve fit to the equation

$$C = a_1 + \frac{a_2}{(z - a_3)^2 + a_4},$$

wherein a_1, a_2, a_3 and a_4 are Lorentzian curve-fitting parameters, z indicates a distance along a focus direction, and said parameter a_3 corresponds to the best focus position along said focus direction.

27. A computer-readable medium capable of holding data corresponding to at least four dark-field image intensity distributions measured at different focus positions, and holding instructions for determining a best focus position based on said data, by performing the steps of:

a) calculating an average intensity and a variance for each of said dark-field image intensity distributions;

b) forming a set of contrast values by calculating a contrast value for each image intensity distribution based on said variance and said average intensity; and

c) determining the best focus position by fitting a Lorentzian function to said set of contrast values plotted as a function of said different focus positions.

28. A computer readable medium according to claim 27, wherein said step b) further includes the steps of:

d) digitizing each said dark-field image such that said image intensity distribution for each said dark-field image is a digitized image intensity distribution comprising discrete gray-scale intensity levels, I_n, corresponding to a discrete plurality of n pixels; and

e) arranging each said digitized image intensity distribution into a histogram, $H(I_n)$, of an amount of said pixels having a given said gray-scale intensity level, I_n.

29. A computer readable medium according to claim 28, further including the steps of:

f) calculating said average intensity for each said discrete image intensity distribution via the equation

$$\langle I \rangle = \frac{\sum_{I_n} H(I_n) I_n}{\sum_{I_n} H(I_n)};$$

g) calculating said variance for each said discrete image intensity distribution via the equation

$$\sigma_I^2 = \frac{\sum_{I_n} H(I_n)(I_n - \langle I \rangle)^2}{\sum_{I_n} H(I_n)}; \text{ and}$$

h) calculating said contrast value, C, for each said discrete image intensity distribution via the equation

$$C = \frac{\sigma_I}{\langle I \rangle}.$$

30. A computer readable medium according to claim 29, wherein said step c) of determining the best focus position includes performing a curve fit to the equation

$$C = a_1 + \frac{a_2}{(z - a_3)^2 + a_4},$$

wherein a_1, a_2, a_3 and a_4 are Lorentzian curve-fitting parameters, z indicates a distance along a focus direction, and said parameter a_3 corresponds to the best focus position along said focus direction.